

## A cross sectional study of salt content in bakery bread in Zagreb, Croatia

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Reducing salt content in bread is the essential part of a national strategy for salt reduction with the goal of long-term national general health improvement. In this study we have analysed salt content in three types of bread available in 25 small and five national industrial bakeries in Zagreb, Croatia. Samples of white wheat bread, dark wheat bread, and other types of bread were collected, and the salt content was determined with the Mohr method. Salt content varied widely between bakeries, with an average content of  $2.30 \pm 0.22$  g per 100 g of bread, which is almost twice the threshold content (1.4 %) defined by the Croatian National Regulation on Cereals and Cereal Products. Further efforts are necessary to teach bakers how to reduce salt content without affecting quality or flavour. These should go hand in hand with continuous monitoring of how the legal provisions are implemented.

KEY WORDS: hypertension; Mohr method; sodium chloride

High intake of sodium and low intake of whole grains and fruits are the leading dietary risk factors for deaths and disability-adjusted life-years (DALYs) in many countries (1). Several studies have shown that high levels of sodium and low levels of potassium increase the risk of arterial hypertension and, consequently, of cardiovascular diseases (CVDs) (2, 3). Sodium restriction in infancy is supposed to have positive effects on lowering blood pressure both in childhood and adulthood (4). CVDs are the leading cause of death in the world (5) and Croatia, where the death rate has reached 5.70 %, and 37 % of population suffers from high blood pressure (6, 7).

According to the World Health Organization (WHO) recommendations (8), the daily intake of sodium and salt in adults should be less than 2 and 5 g, respectively. Considering the average daily intake of salt in Europe, Croatia ranks the third top consumer (after Turkey and Hungary) with an average of 13–16 g (9).

The major sources of sodium in human diet are industrial products (77 %), sodium naturally present in food (12 %), salt added during food preparation (5 %), and salt added during food consumption (6 %) (7).

Bread and other bakery products are staple food in traditional Mediterranean diets (10), including Croatian.

Perl Pirički et al. (11) reported that Croats consumed an average of  $117.7 \pm 78.3$  g of bread per day, while a more recent study (12) reported annual consumption of 80 kg of bread per capita. An estimated amount of salt added to bakery products in Croatia is ~2 %, and the average daily intake of salt through bakery products is estimated at 25–30 % (13–15). A recent study by Pucarín-Cvetković et al. (16) reported an average daily intake of sodium in Croatia of 11.6 g (13.3 g for men and 10.2 g for women), which is almost double the WHO recommendation. The same study established that the mean 24-hour natriuresis was higher in rural than in urban residents.

However, there is no up to date information about salt content in bread and total daily salt intake that could help Croatian health policy makers review their current policies and come up with action plans. The aim of our study was to extend and update our preliminary findings, published in Croatian in 2018 (13) about salt content in bakery bread available in the Croatian capital and largest city, Zagreb.

## MATERIALS AND METHODS

### Sample collection

Bakeries for sample collection were selected from the official database of Zagreb bakeries registered with the Croatian Chamber of Commerce. Of 263 of them, we

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randomly selected five small bakeries from each part of Zagreb (north, south, east, west, and centre) and also included five leading industrial producers of bakery products with shops all over the city (and the nation). In total, the study included 30 bakeries.

Bread samples included three types of bread: white wheat bread, dark wheat bread, and mixed bread made with the flour of other cereals (rye, corn, mixed cereals, special bread and others).

All samples were collected within one week, in the morning hours and analysed on the same day.

#### *Sample preparation*

Bread samples were sliced, cut into smaller pieces, and dried to constant mass in a dry heat steriliser (model ST-01/02, Instrumentaria, Zagreb, Croatia) at  $105 \pm 2$  °C. Dried samples were then cooled, crushed and  $5 \pm 0.1$  mg, placed in a 100 mL glass beaker, and quantitatively transferred with water to a 100 mL volumetric flask. The content was shaken, allowed to stand for 15 min, and filtered through a wrinkled filter paper.

#### *Salt determination*

Salt was determined with the Mohr method for the analysis of Cl<sup>-</sup> and Br<sup>-</sup> ions using AgNO<sub>3</sub> solution in neutral or low alkaline media (17). Each titration was done in triplicate.

The amount of sodium chloride in the analysed samples was calculated and salt content expressed as g/100 g of bread (%).

#### *Statistical analysis*

Data were analysed with the Statistical Package for the Social Sciences (SPSS) program version 23.0 (IBM Corporation, Armonk, NY, United States). In addition to descriptive statistics, one-way and two-way analysis of variance and *t*-test were ran to establish differences between the types of bread and the position and types of the bakeries. Significance was set at  $P < 0.05$ .

## RESULTS

The average salt content in the collected samples was  $2.30 \pm 0.22$  g per 100 g of bread (Table 1) – almost twice the amount defined by the Croatian Regulation of Cereals and Cereal Products ( $< 1.4$  %) (18) for baked bread. In fact, all but one bread sample (1.19 g per 100 g, see Table 1) exceeded the Regulation provision.

The highest average salt content in white wheat bread was 2.39 g per 100 g and in dark wheat bread 2.81 g per 100 g, while in samples of other types of bread, the highest salt content was 2.52 g per 100 g.

Significant differences (*t*-test) were established between white wheat bread and other types of bread ( $P < 0.018$ ).

ANOVA confirmed significant difference between bread types ( $P = 0.027$ ), but there was no significant difference between locations ( $P = 0.459$  for white bread,  $P = 0.624$  for dark wheat bread, and  $P = 0.827$  for other types of bread).

## DISCUSSION

A 2009 salt analysis in bread from Croatian bakeries (14) reported an average of 5 g of sodium per kilogram of bread. The amount of salt used during dough preparation varied a lot, and it was not possible to calculate the absolute amount of salt in bread on the national level.

For comparison, a Mozambique study reported mean sodium content of 0.45 g per 100 g of bread (1.14 % calculated on salt) (19), and a Peru study reported 1.2 g of salt per 100 g of bread (20). In Bosnia and Herzegovina salt content was reported to range between 1.3 and 2.0 g per 100 g of bread (21) and in Serbia between 1.1 and 2.4 g per 100 g of white bread (22).

The association between sodium intake and blood pressure has already been well established and its reduction is perceived as a way to reduce blood pressure. According to a 2019 Eurobarometer special survey, 24 % of respondents from 27 EU countries claimed to “avoid / not eat too much salt” (23). However, reducing salt intake is a long-term process. In 2008, the European Union developed the Framework on voluntary national salt initiatives (24), which set a benchmark of minimum 16 % salt reduction over four years for all food products (25). A survey on the Framework’s implementation in the member states from mid-2008 to mid-2012 (25) showed that bread, cereals, and bakery products were the most important sources of salt in most national diets, with bread contribution of around 20 % or more of the total salt intake. The regions with the highest reported salt intake levels were East and South Europe.

Of all public health interventions into a daily diet, salt reduction seems to be one of the easiest to implement. However, its full implementation should involve interdisciplinary collaboration, especially with food industry (26).

The WHO’s Global Action Plan for the Prevention and Control of Noncommunicable Diseases for 2013–2020 (27), in turn, set the relative salt reduction target to 30 %. In line with these trends, in September 2014, the Croatian government issued a Strategic Plan for Reduction of Salt Intake 20 % (from 11.6 g per day to 9.3 g per day) between 2015 and 2019 (28).

However, all these action plans and targets need full collaboration with all the stakeholders, food industry in particular (26). Some progress in dietary sodium reduction through population-level government initiatives was reported by Cochrane in 2016 (29) for several high-income countries, but the level of evidence was low. Reportedly, United Kingdom achieved significant reduction thanks to pricing interventions and nutrition policies (including on-

**Table 1** Salt content in bread samples (n=90) collected from bakeries across Zagreb

Type of bakery	Location in the city	Type of bread	Statistical parameters			
			Mean (g/100 g of bread)	SD	Range (g/100 g of bread)	CV
Small bakeries	North	White wheat bread	2.01	0.16	1.43–2.32	8.11
		Dark wheat bread	2.62	0.43	1.66–3.78	16.29
		Other types of bread	2.31	0.16	1.94–2.87	6.82
	South	White wheat bread	2.30	0.14	1.96–2.78	6.02
		Dark wheat bread	2.11	0.18	1.43–2.39	8.33
		Other types of bread	2.31	0.16	1.80–2.68	7.04
	East	White wheat bread	2.14	0.18	1.70–2.66	8.46
		Dark wheat bread	2.81	0.46	1.19–3.57	16.40
		Other types of bread	2.52	0.22	1.67–2.84	8.66
	West	White wheat bread	2.39	0.16	2.12–2.97	6.59
		Dark wheat bread	2.56	0.17	2.13–3.13	6.47
		Other types of bread	2.50	0.24	1.80–3.08	9.75
	Center	White wheat bread	2.29	0.14	2.03–2.76	5.90
		Dark wheat bread	2.47	0.25	1.89–3.38	10.05
		Other types of bread	2.24	0.25	1.51–3.04	11.30
Small bakeries	All	White wheat bread	2.23 <sup>a</sup>	0.07	2.01–2.39	3.02
		Dark wheat bread	2.51	0.12	2.11–2.81	4.59
		Other types of bread	2.38 <sup>c</sup>	0.06	2.24–2.52	2.37
Industrial bakeries	All	White wheat bread	2.00 <sup>b</sup>	0.03	1.87–2.05	1.67
		Dark wheat bread	2.56	0.09	2.32–2.84	3.66
		Other types of bread	2.14 <sup>d</sup>	0.06	2.00–2.30	2.62
TOTAL (all bakeries)			2.30	0.22	1.19–3.78	9.48

SD=standard deviation; CV=coefficient of variation; <sup>a,b,c,d</sup> Mean values within a column with different superscript letters were significantly different ( $P<0.05$ )

package nutrition information, restrictions on marketing to children, and food product reformulation).

But most remarkable was the success of public health interventions in Finland, as they have shown that it is possible to change behavioural and nutritional habits (30). Through community-based collaboration with the food industry between 1979 and 2002, urinary sodium excretion dropped from 220 to 170 mmol/L/day among Finnish men and from 180 to 130 mmol/L/day among Finnish women.

In most high-income countries packaged and ultra-processed food contribute with most sugar and sodium consumed in daily diet (31, 32). Food reformulation was reported to reduce as much as 67 % of sodium in bread without affecting bread consumption when potassium chloride and yeast extract replaced it to make up for the loss of flavour (33). In a study from New Zealand (34), the replacement of sodium with potassium and magnesium salts gained 294,000 quality-adjusted life-years (QALYs) over the remaining lifetime, along with the net cost-savings of NZ\$ 1.5 billion. One Croatian study (35) reported that up to 25 % salt reduction did not significantly affect the technological process of bread production (gluten development, rheology properties of dough and fermentation

speed) or its quality. These results are in line with a recent Peruvian study (20).

Croatia has recognised the importance of establishing a rewarding programme for producers whose food meets clearly defined nutritional criteria. Since June 2015, its national programme “Healthy Living” has been implemented to reduce behavioural, biomedical, and socio-medical risks of noncommunicable diseases (36).

## CONCLUSION

Bread salt content in Zagreb still exceeds the recommended threshold of the Croatian National Regulation on Cereals and Cereal Products, and health authorities. Further efforts are necessary to teach bakers how to reduce salt content without affecting the flavour and quality of their products. In addition, consumers should be more vigorously advised to reduce consumption of products with high salt content.

The main shortcoming of this study is the small sample size. Future studies should include more bakeries and all parts of Croatia to get a better insight into salt use in these products. Additionally, they should include information

about the amounts of bread and bakery products consumed by the population in order to estimate total salt consumption through this type of food.

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### Udio kuhinjske soli u kruhu – presječno istraživanje u Zagrebu

Smanjenje udjela kuhinjske soli u kruhu sastavni je dio nacionalne strategije smanjenja unosa soli u Republici Hrvatskoj. Cilj rada bio je analizirati udio kuhinjske soli u trima vrstama kruha, dostupnima u zagrebačkim pekarnicama. Prikupljeni su uzorci kruha iz 25 pekarnica malih obrtnika i od 5 industrijskih proizvođača pekarskih proizvoda na području Grada Zagreba. Udio kuhinjske soli u uzorcima kruha utvrđen je titracijskom metodom po Mohru, s prosječnom vrijednosti od  $2,30 \pm 0,22$  g na 100 g kruha. Dobivene vrijednosti gotovo su dvostruko veće od granične vrijednosti određene *Pravilnikom o žitaricama i proizvodima od žitarica* (1,4 %). Udio soli u svim analiziranim uzorcima bio je veći od preporučenih vrijednosti. Potrebno je daljnje usklađivanje zakonske regulative i prakse radi daljnjeg smanjenja dnevnog unosa soli i poboljšanja zdravlja stanovništva.

**KLJUČNE RIJEČI:** arterijska hipertenzija; Hrvatska; natrijev klorid; pekarnice